

High Performance Scientific Computing
Student Course Guide
Prerequisite: None

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INSTRUCTIONAL MATERIAL

There are no required texts for this course. All examinations will be based solely on lectures, presentations, and notes provided throughout the course. References that may be useful as study aids will be provided throughout the course.

COURSE DESCRIPTION

The course is designed to provide a survey of high performance computing. The focus of the course is to provide students with an introduction to the concepts, tools, and methods for using high performance computers to solve scientific problems.

COURSE OBJECTIVES

Upon the successful completion of this course, the student will be able to:

- Describe high performance computing in the context of scientific computing.
- Understand the concepts of parallel processing as it pertains to high performance computing
- Obtain an account on high performance computing resources at the Oak Ridge National Laboratory facility.
- Navigate Unix type operating systems using a command line interface.
- Understand basic programming using the C programming language.
- Understand and develop basic parallel programs using the C programming language.
- Develop and execute parallel programs on high performance computing resources use parallel programming paradigms such as the message passing interface (MPI)
- Develop models to examine phenomena that will be used to develop applications.
- Describe input/output issues with parallel processing paradigms.
- Describe visualization techniques employed in scientific computing.

COURSE INTRODUCTION

The goal of this course is to provide a survey of high performance computing as it relates to scientific computing. The course will discuss topics related to accessing high performance computing resources, developing applications for those

resources, and executing developed applications. The lectures and presentations are designed to provide knowledge and experiences to students that serve as a foundation for continued learning of high performance computing.

This course is a videoconference course conducted synchronously with the instructor(s) at Oak Ridge National Laboratory. During the course, guest lecturers will provide lectures and presentations on various topics so that students may gain knowledge from differing viewpoints.

WEEKLY COURSE SCHEDULE

The weekly schedule below describes the learning activities that will help you achieve the course objectives listed above and the assessments that will be used to measure your mastery of the outcomes. This schedule is subject to change.

WEEK 1 - Course introduction

Course objective in focus:

- Instructor and students introductions
- HPC at Oak Ridge National Laboratory
- Learn the basic terminology commonly used in high performance computing

Assignment(s)

- Apply for HPC accounts

WEEK 2 & 3 – Introduction to Unix/Linux

Course objective in focus:

- Gain knowledge of interfacing with command line interfaces (CLI)
- Gain knowledge of basic Unix commands
- Gain knowledge of basic scripting techniques

Assignment(s)

- Assignment 1 handed out

WEEK 4 & 5 – Programming basics

Course objective in focus:

- Review of basic programming techniques
- Learn compilation techniques in Unix environment
- Develop application including writing, compiling, debugging, and execution

Assignment(s)

- Assignment 2 handed out
- Quiz 1

WEEK 6 –

Course objective in focus

TOUR OF ORNL

Assignments

- Assignment 3 handed out

WEEK 7 – Parallel programming

Course objective in focus

- Learn parallel concepts
- Learn parallelism on single/multiple processor systems
- Discuss distributed architectures

Assignments:

- Quiz 1

WEEK 8

MID-TERM EXAMINATION

WEEK 9 – Message Passing Interface (MPI)

Course objective in focus

- Learn MPI concepts
- Learn the six most important MPI function calls
- Learn to program in C using MPI

Assignments

- Assignment 3 handed out
- Quiz 2

WEEK 10 – OpenMP

Course objective in focus

- Learn OpenMP concepts
- Learn the six most important OpenMP function calls
- Learn to program in C using OpenMP

Assignments

- Assignment 4 handed out
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WEEK 11 – Model Design

Course objective in focus

- Use linear algebra to simulate real world events
- Translate formulas to parallel code
- Develop simulation based on model

Assignments

- Assignment 5 handed out

WEEK 12 – Parallel Input/Output

Course objective in focus

- Learn concepts of parallel file processing
- Learn current I/O models such as hdf5
- Apply concepts to application

Assignments

- Assignment 6 handed out

WEEK 13 – Visualization

Course objective in focus

- Learn scientific visualization concepts
- Learn importance of data analysis

Assignments

- Assignment 7 handed out

WEEK 14 –

Course objective in focus

TOUR OF ORNL

Assignments

- Assignment 8 handed out

WEEK 15 –

FINAL EXAMINATION

EVALUATION

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| Quizzes and Assignment | 60% |
| Mid Term Examination | 20% |
| Final Examination | 20% |